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[Address] Director General of Patent Office: Kouzo OIKAWA

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[Inventor]

[Address] 5-1 Higashinarashino 7-chome, Narashino-shi, Chiba-ken, Japan c/o Suzuki Metal Industry Co., Ltd.

[Name] Mitsuhide ONODA

[Applicant for Patent]

[Designated Number] 000252056

[Address] 8-2 Marunouchi 1-chome, Chiyoda-ku, Tokyo-to JAPAN

[Name] Suzuki Metal Industry Co., Ltd.

[Agent]

[Designated Number] 100075889

[Address] Hata Bldg. 1-6 Hatchobori 3-chome, Chuoh-ku, Tokyo Japan

[Patent Attorney]

[Name] Toshio Yamamoto

[Telephone number] 03-3297-4098

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[Contents of Attached Documents]

[Document] Specification one-note

[Document] Drawings one-note

[Document] Abstract one-note

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[NAME OF DOCUMENT] Specification

[TITLE OF THE INVENTION] A method for producing an oil tempered wire

[WHAT CLAIMED IS:]

[CLAIM 1]

A method for producing an oil tempered wire comprising: applying an isothermal transformation heat treatment to a wire material having a nonmetallic inclusion controlled; applying a lubrication film after washing with acid; carrying out scalping, after which softening a work hardened layer produced on a surface layer at the time of scalping by annealing and carrying out wire drawing, and then carrying out an oil temper treatment.

[CLAIM 2]

A method for producing an oil tempered wire according to claim 1, wherein an annealing temperature is 500 to 600 degrees Centigrade.

[CLAIM 3]

A method for producing an oil tempered wire according to claim 1, wherein in said annealing, an in-furnace atmosphere is nitrogen in order to suppress an oxidized scale film.

[CLAIM 4]

A method for producing an oil tempered wire according to claim 1, wherein in said annealing, an in-furnace atmosphere is a mixture of nitrogen and oxygen in order to suppress an oxidized scale film, and a quantity of oxygen is controlled.

[CLAIM 5]

A method for producing an oil tempered wire according to claim 1, wherein said wire material is Si-Cr steel.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[RELATED ART]

The present invention relates to a method for producing an oil hardened and tempered wire for use in a coil spring, such as a valve spring used in an internal combustion engine, a torsion spring used in a clutch mechanism for an automobile and the like.

[0002]

[CONVENTIONAL TECHNIQUE]

There has been known a method for producing an oil tempered wire for a coil spring, the method comprising: using a wire material having a nonmetallic inclusion controlled and carrying out an isothermal transformation heat treatment, washing with acid and applying a lubrication film, carrying out scalpting or shaving, and then carrying out an isothermal transformation heat treatment, washing with acid and applying a lubrication film, carrying out wire drawing process and finally applying oil temper treatment. In this case, the isothermal transformation heat treatment with a wire material is often omitted since workability of a wire material is enhanced.

[0003]

The conventional method for producing an oil tempered wire which after the scalping has been carried out the isothermal transformation heat treatment carries out includes: (a) since the wire material is heated to a degree in excess of a transformation temperature, decarburization likely occurs; (b) since the isothermal transformation heat treatment requires a traveling treatment with a strand or wire, it results in, as a dominant cause, producing a damage by the traveling treatment and handling; (c) in the isothermal transformation heat treatment, it is necessary for removal of an oxidized scale film produced during the heat treatment and for providing a lubrication film treatment after washing with acid in order to wire drawing processing; and (d) if there is unevenness of the lubrication film after washing with acid, it interferes an uniformity of adhering state of the oxidized scale in the oil temper treatment after wire drawing and it causes an undesirable influence in forming process of a coil spring (coiling).

[0004]

[PROBLEM TO BE SOLVED BY THE INVENTION]

In view of the aforementioned problem, it is an object of the invention to provide a method for producing an oil tempered wire, which improve quality, achieve reduction in cost and simplify the steps after the scalping.

[0005]

It is a further object of the invention to provide a method

for producing an oil tempered wire which is free from decarburization of a wire material and free from a damage or unevenness of scale on a surface layer after wire drawing and an oil temper treatment have been carried out, to facilitate forming of a coil spring.

[0006]

[MEANS FOR SOLVING THE PROBLEM]

For solving the problems noted above, a method for producing an oil tempered wire according to the present invention comprises; preparing a wire material having a nonmetallic inclusion controlled, carring out scalpting or shaving, softening a work hardened layer produced on a surface layer at the time of scalping by annealing, carrying out wire drawing, and then carrying out an oil temper treatment.

[0007]

[MODE FOR CARRING OUT THE INVENTION]

The present inventor has found that in a method for producing an oil tempered wire for use in a coil spring, to carry out annealing after scalpting or shaving of a wire material having a nonmetallic inclusion controlled is effective for a thereafter wire drawing process. That is, the method for producing an oil tempered wire for use in a coil spring resides in that a work hardened layer produced on a surface layer of a wire material during scalping the wire material is softened by annealing in order to be harmless, then wire drawing and an oil temper

treatment are carried out.

[0008]

Considering a wire drawing workability and a solid solution state of cementite caused by austenite heating at the time of an oil temper treatment after wire drawing process, annealing temperature of a wire material is set to a temperature region from 500 to 650 degrees Centigrade. For the atmosphere at the time of annealing, nitrogen or a mixture of nitrogen and oxygen is used, and preferably, the quantity of oxygen can be controlled. A control of oxygen is made such that an oxidized scale film produced by annealing of a wire material is extremely thin and even. Thus, it is possible to omit the conventional lubrication film treatment after washing with acid for wire drawing process.

[0009]

A film of an oxidized scale caused by annealing prior to wire drawing process of a wire material may be subjected to descaling by means of a shot blast or the like. By making an oxidized scale film due to annealing of the wire material even, the thickness of the oxidized scale after succeeding oil temper process becomes even, and lubricating property at the time of forming process of a coil spring (coiling) can be maintained.

[0010]

[EMBODIMENTS]

Method for producing an oil tempered wire according to the

present invention is characterized by removing unacceptable result to scalping or shaving a wire material and softening a work hardened layer of the wire material produced due to shaving by annealing, thus making it harmless, then wire drawing and finally carring out an oil temper treatment.

[0011]

[Embodiment 1]

There were prepared wire materials A to G and a comparative material H to produce oil tempered wires, in which an alloy steel inclusion is controlled, comprising carbon 0.57% (hereinafter, % means weight% unless otherwise particularly described clearly), silicone 1.45%, manganese 0.69%, phosphorus 0.014%, sulfur 0.004%, chromium 0.67% and iron (the remains), these materials were subjected to an isothermal transformation heat treatment, washing with acid and applying a lubrication film, and scalping or shaving of of the surface. The scalping amount of a wire material is 0.3 mm in diameter (thickness 0.15 mm). Then, annealing of a wire material by batch was carried out in an atmosphere of mixture of nitrogen and oxygen.

[0012]

An annealing temperature of a wire material was varied from 480 to 700 degrees Centigrade to confirm workability of drawing of the wire materials A to G and the comparative material H at respective annealing temperature. The state of the oxidized scale film after annealing of the wire material was extremely thin and

even. Further, the decarburization of the wire materials A to G in annealing was not recognized, but the decarburization on the comparative material H was recognized, as shown in FIG. 4.

[0013]

Next, the oil temper treatment were carried out with respect to a wire materials, which are suitable for drawing wire process. The solidified state of cementite at the time of oil temper treatment was confirmed (refer to FIG. 2). In the oil temper treatment, since heating time is short, when the cementite is formed into sphere, the solid solution of cementite is insufficient by heating and adequate strength was not obtained.

[0014]

A relationship between the annealing temperature and drawing wire workability after the wire materials A to G and the comparative material H of which an inclusion was controlled and were subjected to the isothermal transformation heat treatment, washing with acid and applying a lubrication film and scalping or shaving of the surface are as follows:

[0015]

Wire material A: At an annealing temperature of 450 degrees Centigrade, a breakage occurred during the drawing wire process, which was not practical.

[0016]

Wire material B: At an annealing temperature of 480 degrees Centigrade, the drawing wire process in excess of 80% of

reduction of area was accomplished, but fine crack-like crevices at right angle to wire axis occurred on the surface of the wire material, as shown in FIG. 1.

[0017]

Wire materials C to F: At an annealing temperature of 500 to 650 degrees Centigrade, fine crack-like crevices at right angle to wire axis was not recognized, and the cementite formed into sphere was not found. By austenite heating after drawing wire process, the cementite was sufficiently subjected to solid solution to obtain adequate strength. No unevenness was recognized on the external appearance of the oxidized scale film produced after the oil temper treatment.

[0018]

Wire material G: In the annealing temperature of 700 degrees Centigrade, formation of cementite into sphere progresses, and the solid solution of spherical cementite is insufficient due to heating for changing into austenite after the wire drawing process, and the adequate strength was not obtained.

[0019]

Comparative material H: unevenness was recognized on the external appearance of the oxidized scale film after the oil temper treatment.

[0020]

Evaluation circumstances of the above mentioned wire materials A to G and the comparative material H are summarized in Table 1.

The adequate annealing temperature of the wire materials C to F is 500 to 650 degrees Centigrade.

[0021]

After the oil temper treatment, the inspection of the cracks by eddy current detection was conducted over the full length on the off line. In the wire materials C to F subjected to the batch type annealing treatment, there is no number of cracks per coil (diameter: 6 mm, length: 1500 m), whereas in the comparative material H (subjected to the isothermal transformation heat treatment after scalping) seven cracks per coil were found.

In FIG. 3, A shows no scale-unevenness is present over the full length of the oil. B shows several coils or turns of scale-unevenness are found in a few places within the coil. C shows scores of scale-unevenness are found in one place within the coil. D shows scale-unevenness in which B and C are combined.

Table 1a Evaluation Results

wire mat'l	heat treatment system	temp.	atm'phere	decarburization	wire drawing thick'ns	workability
A	annealing	450	nitrogen	0 (appear)	0 to 1	X (no good)
B	annealing	480	nitrogen	0	0 to 2	Δ
C	annealing	500	nitrogen	0	1 to 3	0 (good)
D	annealing	550	nitrogen	0	1 to 3	0
E	annealing	600	nitrogen	0	1 to 3	0
F	annealing	650	nitrogen	0	2 to 5	0

G	annealing	700	nitrogen	0	3 to 8	0
H	isothermal trans*		reduction	Δ	2 to 15	0

*formation heat treatment

Table 1b Evaluation Results

wire mat'l	oil temper solid solution state	unevenness of scale	number of crack by eddy detection	synthetic evaluation
A	-	-	-	X(no good)
B	-	-	-	X
C	0(good)	0(none)	0	0(good)
D	0	0	0	0
E	0	0	0	0
F	0	0	0	0
G	Δ	-	-	X
H	0	X(appear)	7	X

Table 2 Evaluation items

Evaluation items	evaluation standard
Decarburization	partial decarburization is not present.
Workability	(a) reduction rate of area is more than 80% (b) defect such as scratch is not present on the surface after processing.
solid solution state	cementite is solid solution dispersed evenly.

scale unevenness	A and B in scale-unevenness judgment standard are accepted.

[0022]

[Embodiment 2]

A wire material, in which an alloy steel inclusion controlled, comprising carbon 0.65%, silicone 1.53%, manganese 0.69%, phosphorus 0.007%, sulfur 0.008%, chromium 0.68% and iron (the remains), which are different in component from Embodiment 1, was subjected to an isothermal transformation heat treatment, washing with acid, applying a lubrication film on a surface and scalping amount of 0.3 mm in diameter (0.15mm in thickness) of a wire material.

[0023]

Then, annealing of a wire material by batch was carried out. The annealing temperature was 500 degrees Centigrade. The annealing treatment was carried out with respect to the wire material, after which the wire was drawn to an adequate diameter, and then the oil temper treatment was carried out. At this time, abnormality caused by the wire drawing process, the short in strength in the oil temper treatment, and abnormality such as unevenness of scale were not occurred.

[0024]

[Embodiment 3]

Oil tempered wires used as a high fatigue strength material, each

wire material, in which an alloy steel inclusion is controlled comprising carbon 0.64%, silicone 1.43%, manganese 0.71%, phosphorus 0.006%, sulfur 0.005%, chromium 1.48%, molybdenum 0.47%, vanadium 0.19% and iron (the remains) was washing with acid and applied with a lubrication film, and scalping of a surface in diameter of 0.3 mm (thickness of 0.15 mm) was carried out. Then, the annealing treatment was carried out at 600 degrees Centigrade with respect to the wire materials by the batch. Then, the wire drawing process was carried out with respect to the wire material, after which the oil temper treatment was carried out.

[0025]

Also in the aforementioned high fatigue strength material, the abnormality caused by the drawing wire process, the short in strength in the oil temper treatment, and the abnormality such as unevenness of scale were not occurred.

[0026]

[EFFECT OF THE INVENTION]

As described above, the method for producing an oil tempered wire for use in a valve spring of the internal combustion engine, a coil spring of a clutch mechanism and the like according to the present invention, carrying out scalping, after which softening a work hardened layer produced on a surface layer at the time of scalping by annealing and carrying out wire drawing, and then carrying out an oil temper treatment. Therefore, it is obtained more than 80% of workability of drawing of wire material and high

quality of oil tempered wire.

[0027]

It is useful in the point that no scratch and evenness of scale occur on the surface layer during annealing process of the wire and oil temper treatment, and forming of a coil spring is facilitated.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a photograph showing a surface crack of one wire material according to the method for producing an oil tempered wire by the present invention.

FIG. 2 is a photograph showing a solid solution state of other wire material according to the method for producing an oil tempered wire.

FIG. 3 is a schematic view representative of an evaluation standard in a coil winding state of the wire material according to the method for producing an oil tempered wire.

FIG. 4 is a photograph showing a decarburization state of a comparative wire material.

[NAME OF DOCUMENT] ABSTRACT

[ABSTRACT]

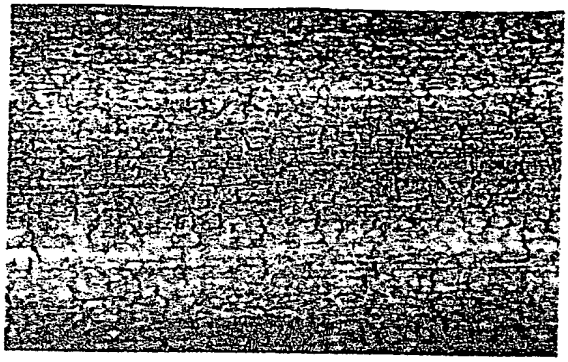
[PROBLEM] To provide a method for producing an oil tempered wire which is free from decarburization of a wire material and free from a damage or unevenness of scale on a surface layer after wire drawing and an oil temper treatment have been carried out, to facilitate forming of a coil spring.

[SOLUTION] The method comprises the step of: applying an isothermal transformation heat treatment to a wire material having a nonmetallic inclusion controlled; applying a lubrication film after washing with acid; carrying out scalping after which softening a work hardened layer produced on a surface layer at the time of scalping by annealing; carrying out wire drawing, and then carrying out an oil temper treatment.

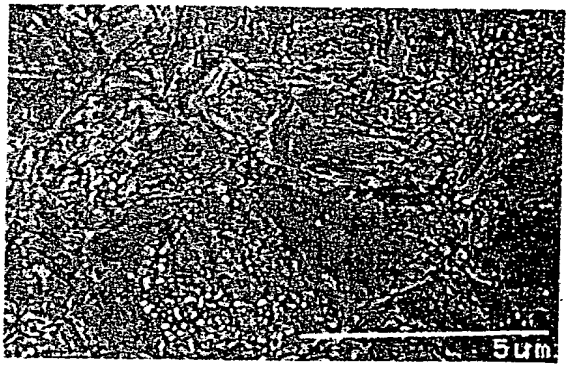
[SELECTED DRAWING] FIG. 1

[Name of Document] Drawings

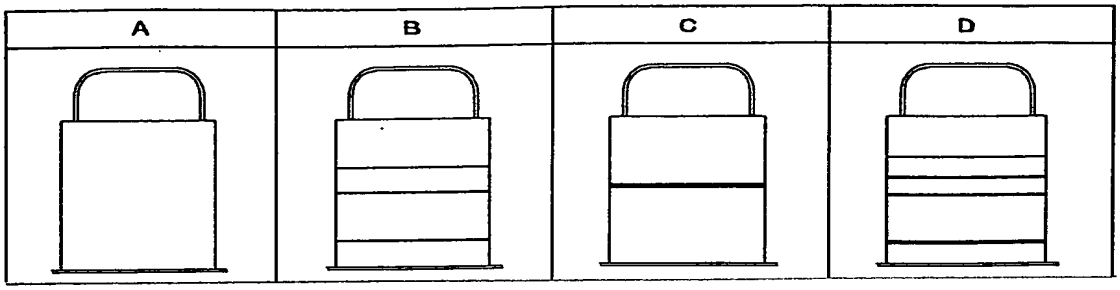
[FIG. 1]



[FIG. 2]



[FIG. 3]



A: No scale-unevenness is present over the full lengthof the coil.

B: Several times of scale-unevenness are found in a few places within the coil.

C: Scores of rolls of scale- unevenness are found in one place within coil.

D: Scale-unevenness in which B-C are combined.

[FIG. 4]